Radiometer on a Chip

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Submillimeter-wave radiometers have traditionally been built by packaging each chip with a distinct function separately, and then combining the packaged chips to form subsystems. Instead of packaging one chip at a time, the radiometer on a chip (ROC) integrates whole wafers together to provide a robust, extremely powerful way of making submillimeter receivers that provide vertically integrated functionality. By integrating at the wafer level, customizing the interconnects, and planarizing the transmission media, it is possible to create a lightweight assembly performing the function of several pieces in a more conventional radiometer. This represents a greater than 50-fold decrease in both volume and mass. The act of combining the individual radiometer functions into a sequence of chips will also improve inter-component matching and reduce the loss associated with the power combining that accompanies today's radiometers.

Most of the gain fluctuations in present-day radiometers are the result of thermal gradients. By reducing the size and mass of the radiometer, the thermal gradients are reduced, thus also reducing their effect on thermal stability. This results in greater measurement stability.

With a size reduction of this magnitude, ROCs will be able to be used in balloons, landers, rovers, and any other place where a complete remote chemical laboratory might be required.

Measuring Luminescence Lifetime With Help of a DSP

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An instrument for measuring the lifetime of luminescence (fluorescence or phosphorescence) includes a digital signal processor (DSP) as the primary means of control, generation of excitation signals, and analysis of response signals. In contrast, prior luminescence-lifetime-measuring instruments have utilized primarily analog circuitry to perform these functions. Such instruments are typically used as optical chemical sensors.

Like the prior instruments, the present instrument is based on the principle of illuminating a specimen with sinusoidally varying light to excite sinusoidally varying luminescence and measuring either the phase shift (φ) between the luminescence oscillations and the excitation signal at a specified frequency (*f*) or the frequency that results in a specified fixed phase shift (typically, 90°. The fluorescence lifetime (τ) is then calculated using $\tau = \tan \varphi / (2\pi f)$. The primary limitation of prior analog instruments was lack of reconfigurability: it was necessary to rewire components to change operating modes for different specimens. In contrast, the DSP hardware in the present instrument makes it possible to switch among a variety of operating modes by making changes in software only.

Modulation Based on Probability Density Functions

This method would have steganographic value.

John H. Glenn Research Center, Cleveland, Ohio

A proposed method of modulating a sinusoidal carrier signal to convey digital information involves the use of histograms representing probability density functions (PDFs) that characterize samples of the signal waveform. Although almost any modulation can be characterized as amplitude, phase, or frequency modulation or some combination of two or all three of them, the proposed method is independent of traditional modes of amplitude, phase, and frequency modulation and neither explicitly includes nor explicitly excludes them.

The method is based partly on the observation that when a waveform is sampled (whether by analog or digital means) over a time interval at least as long as one half cycle of the waveform, the samples can be sorted by frequency of occurrence, thereby constructing a histogram representing a PDF of the waveform during that time interval. Commonly known data-analysis and statistical techniques (e.g., those of pattern recognition or correlation), implemented in software, can reveal a trend in the histogram associated with some aspect of the shape of the sampled segment of the waveform. In the proposed method, the waveform would be shaped, at the transmitter, such that the trend in the histogram to be generated at the receiver would encode a digital datum (e.g., a one or a zero in the case of binary encoding).

A receiver according to this method could be embodied in analog or digital